OPERATIONAL ENVIRONMENTAL CONSIDERATIONS

PROCESS

- Identify Appropriate Operational Environments
  - Land-Based HMMWV Shelter Environment
  - Ship-Based (Surface Ship) Environment
  - Tactical Operations Center (TOC) Environment
- Identify Appropriate Environmental Requirements
  - Natural
  - Induced
  - Qualification Test Methods
- Review Against MAE & TUAV Program Requirements
  - TUAV GCS Environmental Requirements
  - MAE GCS Environmental Requirements
  - Identify Deltas - Modify Environmental Requirements Appropriately
- Establish Environmental Requirements for TCS Block 0 Equipment
  - Review COTS / NDI Data
  - Identify Qualification and Test Method Differences
  - If Necessary - Identify Engineering Changes Required

IEEE P1156.X (DRAFT)

IEEE STANDARD FOR MICROCOMPUTER ENVIRONMENTAL SPECIFICATIONS FOR RACK MOUNTED COMPUTER EQUIPMENT

Scope

This standard is intended to be used as a core specification. It contains the minimum environmental withstand conditions which cover the natural and artificial environments to which rack mounted equipment may be exposed. Performance of the rack mounted equipment can be assessed under the withstand conditions for use, transport and storage as in practice. Withstand conditions include, but are not limited to thermal, mechanical, electrical and atmospheric stresses.

Purpose

The purpose of this standard is to provide a common set of specifications for physical integrity and environmental performance levels for rack mounted computer equipment.

ENVIRONMENTAL CLASSIFICATIONS

Environmental classifications are grouped into Environmental Codes to delineate degrees of environmental hardening required by each piece of equipment.

- **RED**
  Shipboard Severe-Service. Intended primarily for shipboard situations where severe temperature and shock extremes are likely. Survival of mission critical systems is paramount.

- **GREEN**
  Wheeled and tracked vehicle. Intended primarily for use ashore aboard wheeled and tracked vehicles in expeditionary situations.

- **TAN**
  Outdoors. Intended primarily for use in expeditionary situations in an unsheltered uncontrolled environment.

ENVIRONMENTAL CLASSIFICATIONS

- TCS Sea Based (TCS-SB) Configuration
  - Code: **RED**
- TCS Land-Based, Shelterized (TCS-LS) Configuration
  - Code: **GREEN**
- TCS Tactical Operations Center (TCS-TOC) Configuration
  - Code: **TAN**

ENVIRONMENTAL REQUIREMENTS APPLICABILITY

	RED	GREEN	TAN
1. Altitude, Operating		X	X
2. Altitude, Non-Operating	X	X	X
3. DC Magnetic Field Environment	X, a		
4. Dust and Sand		X	X
5. EMI, Emissions	X, b	X, b	X, b
6. EMI, Susceptibility	X, a	X, d	X, d
7. Electrostatic Discharge (ESD)	X	X	X
8. Fungus		X	X
9. Humidity	X, a	X, a, b	X, a, b
10. Immersion			X
11. Leakage Current	X	X	X
12. Noise, Airborne	X, a	X, a	X, a
13. Noise, Structureborne	X	X	X
14. Power	X a, b, c	X b, c, f	X a, b, c, d, e, f
15. Rain			X
16. Salt Fog			X
17. Ship Motion and Attitude	X	X	
18. Shock, High-Impact	X, a	X, b	
19. Shock, Storage and Transportation	X, a	X, a, b	X, a, b
20. Solar Radiation			X
21. Temperature	X, a, b	X, a, b	X, a, c
22. Vibration	X, a	X, b	X, a

OTHER ENVIRONMENTAL REQUIREMENTS

Additional Environmental Requirements:

- Snow
- Icing
- Wind
- Lightning
- Acceleration

ENVIRONMENTS

- NATURAL
  - Temperature
  - Solar Radiation
  - Humidity
  - Rain
  - Snow
  - Icing
  - Fungus
  - Salt Fog
  - Wind
  - Blowing Sand and Dust
  - Altitude
  - Lightning
- INDUCED
  - Vibration
  - Shock
  - Acceleration
  - DC Magnetic Fields
  - Electromagnetic Interference
  - Electrostatic Discharge
  - Immersion
  - Ship Motion and Attitude
  - Noise
  - Leakage Current

ENVIRONMENTAL REQUIREMENTS

- Altitude, Operating:
  - Requirement: Equipment shall operate at altitudes up to 35,000 ft.
  - Test Method: Equipment shall be tested in accordance with MIL-STD-810, Method 500, Procedure II.
- Altitude, Non-Operating:
  - Requirement: Equipment shall withstand transit in an unpressurized cargo bay of an aircraft at 40,000 ft.
  - Test Method: Equipment shall be tested in accordance with MIL-STD-810, Method 500, Procedure 1. Test duration shall be at least 1 hour.
  - DC Magnetic Field Environment, subpart a:
  - Requirement: Equipment shall operate without fault in a steady state DC magnetic field of 3 Oersted (240 A/m), and a magnetic field having a maximum rate of change of 240 A/m per second. Non-operating, the equipment shall withstand a steady state DC magnetic field of 20 Oersted (1600 A/m), and a magnetic field

ENVIRONMENTAL REQUIREMENTS CONTINUED

- DC Magnetic Field Environment, subpart a continued:

  having a maximum rate of change of 1600 A/m per second. The minimum exposure to the steady state field shall be 5 minutes. No particular orientation of the direction of the magnetic field may be assumed. Cathode Ray Tube (CRT) displays shall operate without fault in a steady state DC magnetic field of 3.0 Oersted. A CRT display denoted as a High DC Magnetic Field Environment device shall operate without fault in a steady state DC magnetic field of 5.0 Oersted and a magnetic field having a maximum rate of change of 400 A/m per second. It is desired that, as a goal, ALL equipment shall operate without fault in a steady state DC magnetic field of at least 5 Oersted.

  A fault on a CRT shall be defined in terms of color shift, character distortion and image rotation. There shall be no perceptible color shift to another primary color over any part of the screen. There

ENVIRONMENTAL REQUIREMENTS CONTINUED

- DC Magnetic Field Environment, subpart a continued:

  shall be no perceptible color shift within the quality circle, when displaying a flat red field. The quality circle is defined as a circle whose diameter equals the shortest dimension of the viewable raster area of the CRT as installed in the monitor. For a full screen of repeated text strings, consisting of white characters of the extended ASCII character set in 10-point Courier font over a black background, all characters shall be discernible in terms of character identification and color (white) and there shall be no perceptible physical distortion. Image rotation shall not exceed 5 degrees.

  Test Method: Equipment shall be tested in accordance with DoD-STD-1399, Section 070, Part 1, paragraph 6.

- Blowing Dust and Sand:
  - Requirement: Equipment shall withstand dust and sand.
  - Test Method: Equipment shall be tested in accordance with MIL-STD-810, Method 510, Procedure I and II. Conditions as follows:

ENVIRONMENTAL REQUIREMENTS CONTINUED

- Blowing Dust and Sand continued:
  - Temperature: 23°C and 50°C
  - Humidity: < 30%
  - Air Velocity: Blowing dust min 1.5 m/s required to maintain test conditions; 8.9 m/s for test; blowing sand 18 m/s.
  - Dust composition: Per MIL-STD-810
  - Dust concentration: 10.6 +/- 7 g/m3
  - Sand composition: Per MIL-STD-810
  - Sand concentration: 0.177 g/m3
  - Blowing dust: 6 hrs at 23°C and 6 hrs at 50°C
  - Blowing sand: 90 min/face on most vulnerable surfaces.
  - Operate test item: As required in procedures.

ENVIRONMENTAL REQUIREMENTS CONTINUED

- Electromagnetic Interference (EMI), Emissions, subpart b:
  - Requirement: Electromagnetic conducted and radiated emissions from equipment shall meet the requirements for CE101, CE102, RE101 and RE102 in accordance with MIL-STD-461 for surface ships and submarines. This requirement may be met with filters mounted either internal to the equipment chassis or external on the equipment chassis.
  - Test Method: Electromagnetic radiated and conducted emissions from equipment shall be tested in accordance with MIL-STD-462.

    It is desired, as a goal, that rack and ceiling mounted monitors shall meet RE101. Rack and ceiling mounted monitors which cannot meet RE101 shall be corrected by First Article Test (FAT). Government acceptance of such monitors will be determined by the Contracting Officer following the contractor's engineering efforts to reduce emissions.

ENVIRONMENTAL REQUIREMENTS CONTINUED

- Electromagnetic Interference (EMI), Susceptibility, subpart a:
  - Requirement: Electromagnetic conducted and radiated susceptibility of equipment shall meet CS101, CS114, CS116 and RS103 (14 KHz - 40 GHz at 10 V/m with 18 to 40 GHz for information only) in accordance with MIL-STD-461 for surface ships and submarines.
  - Test Method: Electromagnetic conducted and radiated susceptibility of equipment shall be tested in accordance with MIL-STD-462.
  - Electromagnetic Interference (EMI), Susceptibility, subpart d:
  - Requirement: Electromagnetic conducted and radiated susceptibility of equipment shall meet CS101 and RS103 (10 KHz - 1 GHz at 10 V/m, 1 GHz - 18 GHz at 50 V/m) in accordance with MIL-STD-461 for"Ground" areas.
  - Test Method: Electromagnetic conducted and radiated susceptibility of equipment shall be tested in accordance with MIL-STD-462.

ENVIRONMENTAL REQUIREMENTS CONTINUED

- Electrostatic Discharge (ESD):
  - Requirement: Equipment shall be protected from ESD damage.
  - Test Method: Equipment shall be tested in accordance with MIL-STD-1686.
- Fungus:
  - Requirement: Equipment shall not support fungal growth.
  - Test Method: Equipment shall be tested in accordance with MIL-STD-810, Method 508.
- Humidity, subpart a:
  - Requirement: Equipment shall withstand 95 percent humidity, non-condensing.
  - Test Method: Equipment shall be tested in accordance with MIL-STD-810 Method 507 Procedure I as specified by the following: The equipment shall be tested in an operating (power-on) state. A minimum of five 24 hour temperature/humidity cycles shall be conducted. Each test condition is to be maintained for five hours

ENVIRONMENTAL REQUIREMENTS CONTINUED

- Humidity, subpart a continued:

  with 1 hour allowed for transition and stabilization at the next condition. The temperature and humidity conditions during the I hour transition periods are at the discretion of the test director. However, at no time during the test will condensation occur within the equipment under test. At the end of each test condition (5th, 11th, 17th, and 23rd), the unit shall be observed to ensure it is operating satisfactorily.

  Each 24 hour period shall be conducted as follows:

Hour 0 to hour 5:	95% relative humidity at 35C
Hour 5 to hour 6:	Transition period to 65% relative humidity at 50C

ENVIRONMENTAL REQUIREMENTS CONTINUED

- Humidity, subpart a continued:

Hour 6 to hour 11:	65% relative humidity at 50C
Hour 11 to hour 12:	Transition period to 20C maintaining 65% relative humidity
Hour 12 to hour 17:	65% relative humidity at 20C
Hour 17 to hour 18:	Transition period to 95% relative humidity maintaining 20C
Hour 18 to hour 23:	95% relative humidity at 20C
Hour 23 to hour 24:	Transition to 35C maintaining 95% relative humidity

- Humidity, subpart b:
  - Requirement: Equipment shall withstand 100 percent humidity, condensing.
  - Test Method: Equipment shall be tested in accordance with MIL-STD-810.

ENVIRONMENTAL REQUIREMENTS CONTINUED

- Immersion:
  - Requirement: Equipment shall operate AFTER being immersed in water to a depth of 1 meter (3.25 feet) for 2 hours.
  - Test Method: Equipment packed in its deployed transit case shall be immersed in water to a depth of 1 meter (3.25 feet) for 2 hours. Equipment shall operate following immersion. Equipment which has an integral transport case shall be immersed without an additional transit case. Equipment under test shall be in the stowed non-operating mode.
  - Leakage Current:
  - Requirement: Equipment leakage current shall be limited to 5 mA to ground.
  - Test Method: Equipment shall be tested in accordance with MIL-STD-2036, Appendix F.

ENVIRONMENTAL REQUIREMENTS CONTINUED

- Noise, Airborne, subpart a:
  - Requirement: Equipment generated airborne noise shall be in accordance with MIL-STD-740-1, Grade C, Table I.
  - Test Method: Equipment generated airborne noise shall be tested in accordance with MIL-STD-740- 1, Grade C.
- Noise, Structureborne:
  - Requirement: Equipment generated structureborne noise shall be in accordance with MIL-STD-740-2, Type III.
  - Test Method: Equipment generated structureborne noise shall be tested in accordance with MIL-STD-740-2, Type III.
- Power, subpart a:
  - Requirement: Equipment shall be fully operational within the normal tolerance limits specified for standard shipboard electric

ENVIRONMENTAL REQUIREMENTS CONTINUED

- Power, subpart a continued:

  power service Type I per MIL-STD-1399, Section 300A. The equipment service shall be ungrounded 115V, 60Hz, 3-phase, three-wire delta. Equipment shall comply with the equipment interface requirements of MIL-STD-1399, Section 300A, paragraphs 5.1 through 5.2.10. All equipment shall use a double-pole switch to disconnect both power lines. This requirement may be met by adopting an uninterruptible power supply (UPS) or other device placed between the equipment and the electrical system.

  Test Method: Equipment shall be tested in accordance with the procedures specified in MIL-STD-1399, Section 300A, paragraphs 5.3 through 5.3.9.

  Power, subpart b:

  – Requirement: Equipment shall remain fully operational through power interruptions limited in duration to 100 milliseconds. In the event of longer interruptions, equipment not powered through the

ENVIRONMENTAL REQUIREMENTS CONTINUED

- Power, subpart b continued:

  Power Distribution Unit shall restart within one second following short term power interruptions lasting up to 5 minutes. This requirement may be met by adopting an UPS placed between the equipment and the electrical system.

  Test Method: Equipment shall be tested in accordance with the conditions specified above.

- Power, subpart c:
  - Requirement: Equipment shall be fully operational with power generated in accordance with MIL-STD-1332 with input voltages at 90-140VAC @ 47-440Hz, 180-280VAC @ 47-440Hz and 20-30VDC.
  - Test Method: Equipment shall be tested in accordance with the conditions specified above.

ENVIRONMENTAL REQUIREMENTS CONTINUED

- Power, subpart d:
  - Requirement: Equipment shall be powered from 120VAC (RMS) +15%/-10%, 48 to 63 HZ, single-phase power using a three prong connector rated 125 volts, which meets Federal Specifications J-C-175 and Underwriter's Laboratories Standard UL-1950.
  - Test Method: Equipment shall be tested in accordance with the conditions specified above.
- Power, subpart e:
  - Requirement: Equipment shall be suitable for overseas ashore use and operate at 220 VAC +/- 10%, 50 Hz +/- 3 Hz, single phase power. This feature shall be switchable on the equipment or be supplied separately. Switching the voltage and/or frequency shall not require soldering, special tools, a maintenance technician, or affect the warranty. When service is from 220 VAC +/- 10%, 50 Hz +/- 3 Hz, single phase power, all equipment shall be protected from power surges, with a maximum clamping voltage of 430

ENVIRONMENTAL REQUIREMENTS CONTINUED

- Power, subpart e continued:

  VAC peak to peak, a clamping response time of 5 nanoseconds, with energy dissipation of 50 joules. If this feature is not provided internally, it may be provided externally. The Government shall not be required to install special power configurations such as filter lines or nonstandard wall outlets.

  Test Method: Equipment shall be tested in accordance with the conditions specified above.

- Power, subpart f:
  - Requirement: Equipment shall be fully operational with power generated in accordance with MIL-STD-1275 when used with a global uninterruptible power supply (GUPS).
  - Test Method: Equipment shall be tested in accordance with the conditions specified above.

ENVIRONMENTAL REQUIREMENTS CONTINUED

- Rain:
  - Requirement: Equipment shall withstand rain while being transported and operated without damage or degradation of performance.
  - Test Method: Equipment shall be tested in accordance with MIL-STD-810, Method 506, Procedure 1. Conditions shall be 1.8 inches of rain per hour and wind 40 mph for 40 minutes.
  - Salt Fog:
  - Requirement: Equipment shall withstand salt fog.
  - Test Method: Equipment shall be tested in accordance with IEC 68-2-11Ka modified to 48 hours of exposure.
- Ship Motion and Attitude:
  - Requirement: Equipment shall withstand ship motion and attitude conditions to 45° inclinations in all axis in both operating and non-operating conditions. Equipment designated as portable shall be exempt from this test.

ENVIRONMENTAL REQUIREMENTS CONTINUED

- Ship Motion and Attitude continued:
  - Test Method: The equipment shall be subjected to the test limits specified herein. The equipment shall be energized and fully operating during the applicable test. The equipment shall be inclined at the rate of 5 to 7 cycles per minute in one plane to angles of 45° on both sides of the vertical for a period of not less than 30 minutes. During the inclination testing, equipment with drawer slides shall be extended on its slides, to verify that the slides have sufficient lateral strength to support the equipment with inclination in all test directions. For equipment whose operation is degraded when the drawer is extended, for example due to interlocks, the tests shall also be performed with the drawer slides closed. The test shall be repeated with the equipment reoriented 90° to the plane in which it was originally tested. At the conclusion of these cyclic tests, the cyclic motion shall be stopped and the inclination adjusted to an angle of 15°. The equipment

ENVIRONMENTAL REQUIREMENTS CONTINUED

- Ship Motion and Attitude continued:

  shall then be operated for a sufficient period to ensure that the continuous operation can be maintained. The equipment shall then be rotated through the vertical to 15° in the opposite direction and the test for continuous operation repeated. The test shall be repeated with the equipment reoriented 90° to the plane in which it was originally tested.

- Shock, High-Impact Shipboard, subpart a:
  - Requirement: Equipment shall withstand mechanical shock conditions as evidenced by MIL-S-901, Grade A, Class I or II, Type A. Equipment shall maintain normal operation before, during and after the shock event.
  - Test Method: Equipment shall be tested in accordance with MIL-S-901, Grade A, Class I or II, Type A. Unless otherwise specified, the test shall require a total of nine blows and will be conducted utilizing a vertical and a single incline fixture. The user reserves

ENVIRONMENTAL REQUIREMENTS CONTINUED

- Shock, High-Impact Shipboard, subpart a continued:

  the right to use alternate test methods per MIL-S-901. Equipment shall maintain normal operation before, during and after the shock event. In addition, for Class II equipment, the user reserves the right to require successful completion of the low frequency (12-16 Hz) fixture test per MIL-S-901.

  Shock, High-Impact Shipboard, subpart b:

  – Requirement: Equipment shall withstand mechanical shock conditions as evidenced by MIL-S-901, Grade B, Class I, Type A. Equipment designated as portable shall be exempt from shock testing per MIL-STD-2036.
  – Test Method: Equipment shall be tested in accordance with MIL-S-901, Grade B, Class I, Type A. Unless otherwise specified, the test shall require a total of nine blows and will be conducted utilizing a vertical and a single incline fixture. The Government reserves the right to use alternate test methods per MIL-S-901.

ENVIRONMENTAL REQUIREMENTS CONTINUED

- Shock, Storage and Transportation, subpart a:
  - Requirement: Equipment shall withstand storage and transportation shock.
  - Test Method: Federal Test Method Std. 101°C, Test Procedures For Packaging Materials: Method 5007.1, Free Fall Drop Test, and Method 5008.1, Edgewise-Drop (Rotational) Test.
- Shock, Storage and Transportation, subpart b:
  - Requirement: Equipment (in transit case) shall withstand three drops from a height of three feet, on each face, onto hard-packed earth (or 2-inch plywood backed by concrete). Survive one 30° rotational drop (without transit case) from each bottom edge.
  - Test Method: Equipment shall be tested in accordance with MIL-STD-810, Method 516.4, Procedure IV (in transit case) and Procedure VI (without transit case).

ENVIRONMENTAL REQUIREMENTS CONTINUED

- Solar Radiation:
  - Requirement: Equipment shall withstand solar radiation.
  - Test Method: Equipment shall be tested in accordance with MIL-STD-810, Method 505, Procedure II.
- Temperature, subpart a:
  - Requirement: Equipment shall withstand non-operating temperatures of -25°C to +60°C.
  - Test Method:

    High Temperature: Equipment shall be tested in accordance with MIL-STD-810, Method 501, Procedure II as specified by the following: The unit (non-operating) shall be subjected to three 24 hour cycles between 40°C and 60°C. The temperature shall be raised from 40°C to 60°C in 12 hours and lowered 60°C to 40°C in 12 hours. After 3 cycles adjust the temperature to 50°C, maintain for 6 hours, then operate the unit for not less than 2 hours.

ENVIRONMENTAL REQUIREMENTS CONTINUED

- Temperature, subpart a continued:

  Low Temperature: Equipment shall be tested in accordance with MIL-STD-810, Method 502, Procedure I (Storage) and II (Operation) as specified by the following: The unit (non-operating) shall be subjected to -25°C for a period of not less than 4 hours after temperature stabilization of the unit. Adjust the temperature to 0°C and maintain until temperature stabilization of the unit, then operate the unit.

  Temperature, subpart b:

  – Requirement: Equipment shall withstand operating temperatures based on the following operating conditions:

    Rack Mounted: +10°C to +40°C

    Tied Down/Portable: +10°C to +35°C

  – Test Method: Same as subpart a above.

ENVIRONMENTAL REQUIREMENTS CONTINUED

- Temperature, subpart c:
  - Requirement: Equipment shall withstand 0°C to +50°C, operating.
  - Test Method: Same as subpart a above.
- Vibration, subpart a:
  - Requirement: Equipment shall withstand Type I vibration as specified in MIL-STD-167-1.
  - Test Method: Vibration testing shall be performed at the system or end-item level. All the hardware, including cables and connectors shall be exposed to Type I vibrations as specified in MIL-STD-167-1. The items shall be energized during vibration and appropriate input signals applied to observe any abnormal conditions of the output functional characteristics. The Government Test Director will make certain testing decisions (i.e. sensor placement, beginning axis, etc.). Vibration tests shall also include the test methods specified below.

ENVIRONMENTAL REQUIREMENTS CONTINUED

- Vibration, subpart a continued:

  Exploratory Vibration Test: The exploratory test will sweep through the full frequency range (5 to 50 Hz), stopping at each discrete frequency for a duration of fifteen (15) seconds. This test will be used to determine resonant frequency points which will be used during the vibration endurance test.

Frequency Ranges (Hz)	Amplitudes (Inches)
5 - 33	0.010 +0.002
34 - 50	0.003 plus zero, minus 0.001

  Cycle Test: The cycle test will test each discrete frequency from 5 Hz to 50 Hz for a duration of five (5) minutes. The chart below will be used for determining the required test frequency/amplitude.

ENVIRONMENTAL REQUIREMENTS CONTINUED

- Vibration, subpart a continued:

Frequency Ranges (Hz)	Amplitudes (Inches)
5 - 15	0.030 + 0.006
16 - 25	0.020 + .004
26 - 33	0.010 + .002
34 - 40	0.005 + .001
41 - 50	0.003 plus zero, minus 0.001

Endurance Test: The resonant dwells of frequency(s) vs. measured amplitude(s) shall be determined from the exploratory test. From this data, the Government Test Director will select up to three frequency(s) to be utilized during the Endurance test. The Endurance test will not exceed the maximum of (2) hours. If no resonance is observed, this test shall be performed at 50 Hz.

ENVIRONMENTAL REQUIREMENTS CONTINUED

- Vibration, subpart b:
  - Requirement: Equipment shall operate during wheeled vehicle and tracked vehicle motion. Motion may be that of a vehicle traveling 55 mph (88km/hr) over improved highways and improved unpaved roads, up to 35 mph (56km/hr) over secondary roads and up to 10 mph (16km/hr) over cross-country terrain.
  - Test Method: Same as subpart a above.